

improving the resistance of halogen-containing polymers to deterioration when heated to 350° F (177° C) during processing. The sulfides may be made by heating stoichiometric quantities of a mercaptoalkyl ester of a carboxylic acid or an alkyl mercaptocarboxylate and an organotin chloride having the formula:

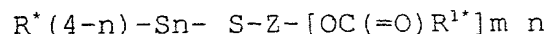


wherein R' is an alkyl group having from 1 to 12 carbon atoms, Hal is a halogen having an atomic weight of from 35 to 127, preferably chlorine, and z is any number from 1 to 3; in water and ammonium hydroxide to about 30°C (86°F), slowly adding an alkali metal mono- or polysulfide, and heating the reaction mixture further to about 45°C before separating the product from said mixture.

Alternatively, the sulfide may be made by mixing a monoalkyl- or dialkyltin sulfide with an organotin mercaptide and by other procedures well known in the stabilizer art.

The sulfides of a mercaptoalkyl ester of a carboxylic acid are characterized by an equilibrium mixture of one or more alkyltin halides of Formula II, one or more mercaptides of Formula III and one or more alkyltin mono- or polysulfides or oligomers thereof, and the alkyltin mono- and polysulfides having the Formula IV.

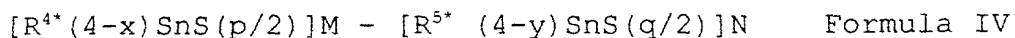
Formula III reads as follows:



wherein R\* is an alkyl radical having from 1 to 12 carbon atoms; R<sup>1\*</sup> is hydrogen, a hydrocarbyl radical, a hydroxyhydrocarbyl radical, or R<sup>2\*</sup>C(=O)OR<sup>3\*</sup>, wherein R<sup>2\*</sup> is alkylene, hydroxyalkylene, phenylene, or -CH=CH-, and R<sup>3\*</sup> is hydrogen, a hydrocarbyl radical, a hydroxyhydrocarbyl radical, or an alkylcarboxyalkylene radical; Z is an alkylene or

hydroxyalkylene radical of at least 2 carbon atoms up to 20 carbon atoms; m is an integer from 1 to 3, n is from 2 to 3, and the valency of Z is m + 1.

Formula IV is representative of linear structures as well as of cyclic trimers and adamantyl rings:



wherein  $R^{4*}$  and  $R^{5*}$  are independently alkyl radicals having from 1 to 12 carbon atoms and are bonded to Sn; x is 2 or 3; y is 2 or 3; p and q are 2 to 20, preferably 2-4; and M and N are 0-10, preferably 0-4, but  $M \neq N = 0$ ; with the proviso that when  $4-x=(4-y)$ ,  $p=q$ , and when  $(4-x) \neq (4-y)$ ,  $p \neq q$ .

It should be understood that the structures of the sulfides produced by the processes mentioned above are very complex. The reactions are believed to produce an equilibrium mixture composed of several different but related products. As will be appreciated by those of ordinary skill in chemistry, equilibrium mixtures inherently include the starting materials as well as the products of any reaction between them. The chemical and patent literature contain numerous examples demonstrating that members of different classes of organotin compounds may react with one another under certain conditions to yield products containing one or more tin atoms wherein at least a portion of the tin atoms are bonded to different combinations of radicals than they were before being mixed together. Accordingly, the sulfides are believed to include bis[monoorganotin)-bis(thioalkyl-carboxylate)] monosulfides and polysulfides, bis[(diorganotin)-mono(thioalkyl carboxylate)]monosulfides and polysulfides, and products which arise during equilibrium reactions among said mono- and polysulfides, including monoalkyltin tris(thioalkyl carboxylates), dialkyltin

bis(thioalkyl carboxylates), mono- and di-organotin mono- and polysulfides, and oligomers thereof, as well as the starting materials themselves. The sulfide of an alkyl ester of a mercaptocarboxylic acid is likewise believed to include bis[monoorganotin)-bis(alkyl mercaptocarboxylate)] monosulfides and polysulfides, bis[(diorganotin)-mono(alkyl mercaptocarboxylate)] monosulfides and polysulfides, and products which arise during equilibrium reactions among said mono- and polysulfides, including monoalkyltin tris(alkyl-mercaptopropionates), dialkyltin bis(alkylmercapto- carboxylates), mono- and di-organotin mono- and polysulfides, and oligomers thereof.

The polysulfides include mixtures of compounds having from 2 to 10 sulfur atoms linked together. Mixtures of monosulfides and polysulfides having from 2 to 4 sulfur atoms are preferred.

In addition to the epoxy compounds and organic phosphites mentioned above, other conventional non-metallic stabilizers can also be included in the PVC compositions of the present invention. Thus, there can be included from 0-0.75%, preferably from 0.01-0.75%, based on the weight of the resin, of sulfur containing compounds such as dilaurylthiodipropionate, distearyl 3,3'-thiodipropionate, dicyclohexyl-3,3'-thiodipropionate, dioleoyl-3,3'-thiodipropionate, dibenzyl-3,3'-thiodipropionate, didecyl-3,3'-thiodipropionate, dibenzyl-3,3'-thiodipropionate, diethyl-3,3'-thiodipropionate, lauryl ester of 3-methylmercapto-propionic acid, lauryl ester of 3-butylmercapto-propionic acid, lauryl ester of 3-lauryl mercaptopropionic acid, and phenyl ester of 3-octyl mercaptopropionic acid.